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FORM PTO-1350 (REV. 11-2000) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE		ATTORNEY'S DOCKET NUMBER NREL 97-33 U.S. APPLICATION No. 09/17743 097762719
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371		
INTERNATIONAL APPLICATION NO. PCT/US99/17743	INTERNATIONAL FILING DATE 5 AUGUST 1999	PRIORITY DATE CLAIMED 10 AUGUST 1998
TITLE OF INVENTION A DURABLE CORROSION AND ULTRAVIOLET-RESISTANT SILVER MIRROR		
APPLICANT(S) FOR DO/EO/US GARY J. JORGENSEN, RANDY GEE AND DAVID E. KING		
Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:		
1. <input checked="" type="checkbox"/> This is a FIRST submission of items concerning a filing under 35 U.S.C. 371. 2. <input type="checkbox"/> This is a SECOND or SUBSEQUENT submission of items concerning a filing under 35 U.S.C. 371. 3. <input checked="" type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below. 4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 3.1). 5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371(c)(2)) a. <input type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau). b. <input type="checkbox"/> has been communicated by the International Bureau. c. <input checked="" type="checkbox"/> is not required, as the application was filed in the United States Receiving Office (RO/US). 6. <input checked="" type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)). a. <input type="checkbox"/> is attached hereto. b. <input checked="" type="checkbox"/> has been previously submitted under 35 U.S.C. 154(d)(4). 7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)) a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau). b. <input checked="" type="checkbox"/> have been communicated by the International Bureau. c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired. d. <input type="checkbox"/> have not been made and will not be made. 8. <input checked="" type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)). 9. <input checked="" type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)). 10. <input type="checkbox"/> An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).		
Items 11 to 20 below concern document(s) or information included:		
11. <input checked="" type="checkbox"/> An Information Disclosure Statement under 37 CFR 1.97 and 1.98. 12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included. 13. <input type="checkbox"/> A FIRST preliminary amendment. 14. <input type="checkbox"/> A SECOND or SUBSEQUENT preliminary amendment. 15. <input type="checkbox"/> A substitute specification. 16. <input type="checkbox"/> A change of power of attorney and/or address letter. 17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825. 18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154(d)(4). 19. <input type="checkbox"/> A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4). 20. <input checked="" type="checkbox"/> Other items or information:		
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A DURABLE CORROSION AND
ULTRAVIOLET-RESISTANT SILVER MIRROR

Technical Field

This invention relates to specular silver mirrors. More particularly, it relates to a durable corrosion and ultraviolet-resistant silver mirror for use in solar reflectors.

Background Art

Insufficient weather protection and ultraviolet degradation are problems, which are encountered when using solar reflectors made of a flexible specular silver mirror. When used outdoors, these mirrors must be durable and ultraviolet light (UV) resistant in order to retain their dimensional stability, aesthetic appearance, and specular-reflectance in the visible, ultraviolet, and near infra-red wavelengths.

Specular-reflectance is provided in a flexible silver mirror through a silvered composite lamina, having a thin layer of silver vapor-deposited on the surface of a flexible polyester substrate. Silver is the preferred metal because its reflectivity is substantially higher than that of other metals, such as aluminum. To retain specular reflectance over time, the prior art has focused on the application of advanced adhesives and protective films, layered over the polyester substrate and silver layer, to protect the mirrors from abrasion, weathering, and ultraviolet degradation.

Early techniques used to protect solar mirrors from abrasion, weathering, and ultraviolet degradation were developed with aluminum mirrors. For example, in U.S. Pat. No. 4,307,150, a solar reflector is disclosed wherein an opaque aluminum surface, vapor-deposited on a flexible polyester support-sheet, is protected from corrosion and weathering with an inter-polymer layer of acrylate or methacrylate copolymers. The support sheet consists of a biaxially oriented polyethylene terephthalate lamina having conventional slip agents, to facilitate winding, and a second polyethylene terephthalate lamina which contains no slip agent.

Silver is higher in specular reflection than aluminum. Thus, the logical assumption had been to substitute silver for aluminum in the solar reflector described above. However, this approach has been reported, in U.S. Pat. No. 4,645,714, to result in two undesirable phenomena. First, silver is susceptible to corrosion either through the development of pin holes in the acrylate coating or along peripheral portions of the silver-coated film. Second, a thin layer of silver, unlike a thin layer of

aluminum, has a spectral window through which ultraviolet ("UV") light readily passes. The peak transmission of this light is at 320 nm, and sunlight contains ultraviolet light at this wavelength. The transmission of ultraviolet light through the silver layer degrades the underlying polyester substrate causing bubbles in the adhesives, commonly used to adhere the substrate to a rigid support. This degradation and bubbling reduces the aesthetic and specular functional properties of the solar mirror.

Corrosion inhibitors and UV absorbers, incorporated into the adhesives or protective film coatings overlaying a polyester and silver mirror substrate, have been used to retain these functional properties. However, while corrosion inhibitors do reduce corrosion, they frequently impart an unacceptable color to the mirror, over time, and do not block the ultraviolet light. In contrast, when ultraviolet light absorbers are incorporated into a protective polymer overlay, the rate of polyester support degradation is lessened, but silver corrosion is aggravated. Thus, attempts have been made to isolate the corrosion inhibitor and ultraviolet absorber elements from the mirror's reactive components in order to eliminate these undesirable effects.

In Roche, U.S. Pat. No. 4,645,714, a corrosion resistant silver mirror is disclosed wherein a corrosion inhibitor, and an ultraviolet absorber are each incorporated into separate thin overlays of an acrylate inter-polymer paint. The specular reflective mirrors are formed by vapor-depositing silver over a polyester support film. Ultraviolet degradation of the polyester support, and consequent bubbling of the underlying adhesive, is reduced by incorporating UV absorbers in a second polymer coating that is applied over a first polymer coating, which incorporates a corrosion inhibitor. The first polymer coating is applied directly over the silver reflective surface. The polymeric substrate, a coextruded biaxially oriented polyester foil, comprises: (1) a polyethylene terephthalate lamina containing conventional slip agents to facilitate winding; and (2) a polyethylene terephthalate lamina containing no slip agent, which results in an optically-smooth exposed surface. The silver specular reflective layer overlies the smooth surface, of the coextruded film, and is bonded thereto. Layered over the silver is a first acrylate or methacrylate inter-polymer coating, having a 0.5 to 2.5% glycol dimercaptoacetate dispersant, which serves as a coupling agent, primer, and corrosion inhibitor. This coating weighs 1-4 g/m². Overlying the first acrylate coating, is a second acrylate

coating containing an ultraviolet absorber effective throughout the 300-400 nanometer range. The weight of the second coating is 4-8 g/m². Inclusion of the corrosion inhibitor and the UV absorber into separate layers is designed to keep the UV absorber out-of-contact with the silver, and to avoid any corroding effect. On the opposite side of the coextruded polyester support is a uniform coating, weighing about 10-15 g/m², of a tacky and pressure-sensitive adhesive (95:5 isooctyl acrylate:acrylamide copolymer). A conventional release liner, such as a silicone-coated polyester film, may be used to protect the adhesive prior to use. The disclosure of U.S. Pat. No. 4,645,714 is incorporated by reference as though fully set forth herein.

It is believed, however, by Hutchinson, U.S. Pat. No. 5,118,540, that the reflective films described in U.S. Pat. Nos. 4,307,150, and 4,645,714 are generally unsuitable for solar energy applications. Under outdoor conditions, the thin acrylate flood coat of these films tends to weather poorly and to quickly erode. These coatings thus offer an insufficient protective barrier to abrasion and moisture. Where the solar mirror comprises a substrate having a polyester support sheet and a layer of silver, as the outer acrylate flood coat, containing UV absorbers, erodes, ultraviolet light degrades the polyester support, and the mirror's aesthetic appearance and optical efficiency fail. In order to mitigate this problem, Hutchinson discloses the use of corrosion inhibitors and ultraviolet absorbers in an adhesive, which is used to bond an abrasion and moisture resistant fluorocarbon protective coating over a polyester and silver mirror substrate. The relevant embodiment, therein, describes a corrosion and ultraviolet light resistant flexible reflective film, where the respective inhibitors and absorbers are incorporated into separate coatings of an adhesive. A thin layer of silver is vapor-deposited on a flexible polyester support sheet, producing the specular silver surface. The adhesive is used to bond a fluorocarbon film, having an abrasion and weather resistant function, to the surface of the silver. The adhesive is applied in two separate layers. The first adhesive layer is adjacent to the silver deposit and contains a corrosion inhibitor. The second adhesive layer contains a UV absorber and overlays the first adhesive layer for use in bonding the fluorocarbon protective film to the silver surface. The use of adhesives to bond the fluorocarbon film to the silver surface is a required element, of this construction, because fluorocarbon films do not bond to metal surfaces. However, this construction is not without its deficiencies

when used, over time, as a solar mirror. Under ultraviolet light, the application of advanced adhesives (those incorporating UV absorbers and corrosion inhibitors) directly onto a silver substrate has resulted in degradation of the silver/adhesive interface. When silver is adhered directly to acrylic films tunnel and delamination failures have also occurred. Moreover, fluorocarbon protective films, without UV absorbers, often provide an insufficient weather resistant shield. For these reasons, it is believed that these silver mirrors when applied as solar reflectors remain lacking in long-term durability, which results in a loss of optical efficiency and aesthetic appearance.

In view of the foregoing considerations, a need therefore exists for a durable silver mirror, which is corrosion and weather resistant, effectively screens ultraviolet light, and retains its specular optical efficiency and aesthetic appearance when used as a component in solar reflectors.

SUMMARY

It is therefore an object of the invention to provide a durable silver mirror for use in solar reflectors.

It is another object of the invention to provide a durable silver mirror, which is corrosion and weather resistant, effectively screens ultraviolet light, and retains its specular optical efficiency and aesthetic appearance when used as a component in solar reflectors.

It is yet another object of the invention to provide a method for making a flexible silver mirror for use in solar reflectors.

The foregoing specific objects and advantages of the invention are illustrative of those which can be achieved by the present invention and are not intended to be exhaustive or limiting of the possible advantages which can be realized. Thus, those and other objects and advantages of the invention will be apparent from the description herein or can be learned from practicing the invention, both as embodied herein or as modified in view of any variations which may be apparent to those skilled in the art.

Briefly, the invention provides, in a silver mirror having a polymeric substrate, a thin specular-reflective silver layer overlying the substrate and bonded thereto, and a thin protective layer of film-forming polymer overlying the exposed surface of the silver layer, the protective layer firmly adherently bonded thereto, the

improvement, comprising: an ultraviolet absorbing polymer film adhered to the exposed surface of the protective layer.

Unless specifically defined otherwise, all technical or scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although any methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, the preferred methods and materials are now described.

Brief Description of the Drawings

Figure 1 is a cross-sectional view of the simplest form of the invention.

Figure 2 is a cross-sectional view of a preferred form of the invention.

Figure 3 is a cross-sectional view of another preferred form of the invention.

Figure 4 is a plot of the measured Spectral Hemispherical Reflectance, as a function of wavelength, which illustrates the optical clarity of the embodiment according to Figure 3.

Description of the Preferred Embodiments

The present invention provides a durable silver mirror, and a method for making the mirror, having weather and corrosion resistance and effective ultraviolet screening. These features provide long-term durability and a retention in specular optical-efficiency and aesthetic. These silver mirrors are useful for application to solar reflectors, used outdoors.

With reference now to the drawing figures, wherein like numerals represent like elements, there is generally shown the silver mirror **10**, in Figure 1, in its most basic configuration. The silver mirror **10** is comprised of a polymeric substrate **11** having a thin, vapor-deposited, silver overlay **13**, which exhibits a specular reflectance. Bonded to the surface interface **14**, of the silver layer **13**, is a thin layer of a film-forming protective polymer **15**. Long-term durability and the retention of specular optical-efficiency and aesthetic appearance is provided through the incorporation of a protective shield overlay **17**, comprising a transparent multi-polymer film, such as acrylic, that incorporates UV absorbers. This film **17** also shields the reflective interface **14** and the underlying adhesives from UV degradation. Lamination of the UV absorbing polymer **17** to the protective film-forming polymer

15 is done by means of an optical quality adhesive, a solvent weld, or ultrasonic weld at interface 19. These adherent means are characterized by good adhesion, high optical performance, and durability. Both the supersubstrate 17, and the film-forming polymer 15, are sufficiently transparent to visible light such that the silver 13 specular surface may be observed and the high inherent reflectivity of the silver 13 fully utilized.

Referring now to Figure 2, mirror 20, of the drawing, is a preferred embodiment of the invention. In this embodiment, silver layer 13 is vapor-deposited on the smooth-surface of a coextruded biaxially oriented polyester foil 21, which consists of a polyethylene terephthalate lamina 21B having conventional slip-agents, and a polyethylene terephthalate lamina 21A which does not contains a slip-agent resulting in an exposed surface that is optically smooth. On the opposite surface of lamina 21B is normally tacky and pressure-sensitive adhesive layer 27, which in turn is protectively covered by a release liner 18. For application of the mirror 20 to a solar reflector, the release liner 18 is removed and the adhesive layer 27 is used to firmly adhere the mirror 20 to the solar reflector base (not shown).

In the figure, the layered film-assembly 26 of mirror 20 may be, for example, a high performance specular silver reflective film, such as the SILVERLUX polyester film, which is manufactured by the 3M Company under the trade designation SS-95P. The SILVERLUX film 26 is conventional in construction and is commercially available with a removable premask (not shown) to protect the silver surface 13 prior to application. Layer 15 is a thin acrylate coating that incorporates a corrosion inhibitor and layer 16 is another thin acrylate overcoat that incorporates UV absorbers. The SILVERLUX film 26 uses a pressure-sensitive adhesive layer 27 for ease in permanent application to most smooth non-porous substrates, and an adhesive 27, which is protected by a release liner 18. The two thin acrylate films 15 and 16, of assembly 26, tend, however, to weather poorly and too quickly erode away when used outdoors as solar mirrors. Assembly 26 incorporates a polyester support sheet 21 and a layer of silver 13. The presently preferred material for the substrate 21 is, as previously indicated, polyethylene terephthalate, which is susceptible to ultraviolet light degradation upon weathering. Ultraviolet light causes the polyester support sheet 21 to degrade and the reflective film 26 too eventually lose specular reflectivity during accelerated weathering.

This degradation and loss of specular reflectance is, however, substantially overcome through bonding an overlay of a highly transparent acrylic multipolymer film 17, containing UV absorbers, to the surface of film 26. Disposed between the second acrylate layer 16 and the acrylic multi-polymer film 17 is a bonding interface 29. In Figure 2, an adhesive 31 may be used to bond layers 16 and 17. The adhesive 31 is highly optically transmissible to visible, ultraviolet, and near infra-red light. The acrylic multipolymer film 17, with UV absorbers incorporated therein, is a durable weather resistant acrylic shield which retains an adequate strength, for its function, and original aesthetics with outdoor exposure over time. The acrylate polymer film 17 may be, for example, the KORAD KLEAR high gloss acrylic film, which is commercially available under the trade designations KORAD KLEAR 05005 in a roll thickness of 2-8 mil, or the 3M Company extruded acrylic film sold under the trade designation 3M X09105, which is 3.5 mil thick.

Turning now to Figure 3, mirror 30 is another preferred embodiment of the invention. Here, as in Figure 2, disposed between second polymeric layer 16 and acrylate polymeric layer 17 is a bonding interface 29. However, unlike Figure 2, layer 16 and acrylic polymer film 17 are bonded together by means of a solvent or ultrasonic weld, which thereby eliminates the need for the adhesive compound 31 of Figure 2. While the weld at interface 29 is preferably provided by an ethanol organic solvent, it is understood that other organic solvents, such as acetone, having like properties would also be suitable for bonding layers 16 and 17.

EXPERIMENT

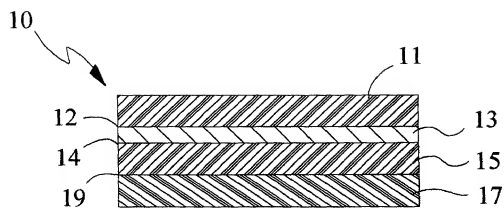
In parallel runs, separate samples of KORAD KLEAR 05005 (1 3/4 * 2 5/8 inches) were solvent-welded, with ethanol, over a SILVERLUX reflective film. This method resulted in a silver mirror according to the construction set forth in Figure 3, of the drawings. The ethanol solvent weld, in peel tests, resulted in an extremely adherent bond. Referring now to Figure 4, it is shown a plot of the measured Spectral Hemispherical Reflectance, as a function of wavelength, for the KORAD KLEAR 05005 film solvent-welded to the SILVERLUX film. As shown in the figure, the solvent-welded KORAD KLEAR 05005 and SILVERLUX reflector construction resulted in a silver mirror, which retained its high optical clarity throughout the UV and visible spectrum.

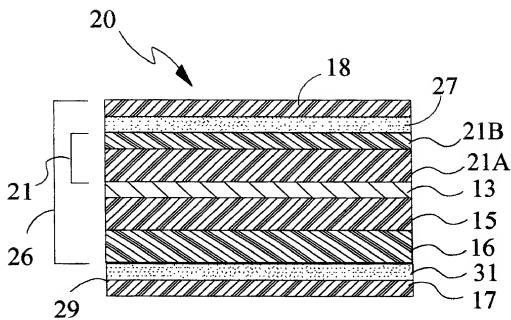
The foregoing description is considered as illustrative only of the principles of the invention. Furthermore, since numerous modifications and changes will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and process shown as described above. Accordingly, all suitable modifications and equivalents may be resorted to falling within the scope of the invention as defined by the claims which follow.

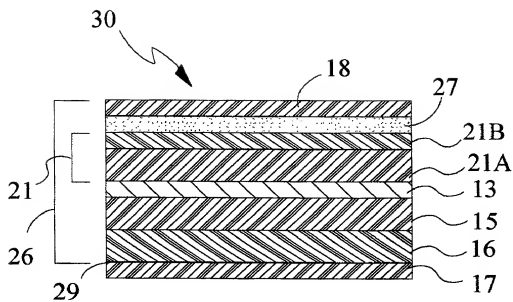
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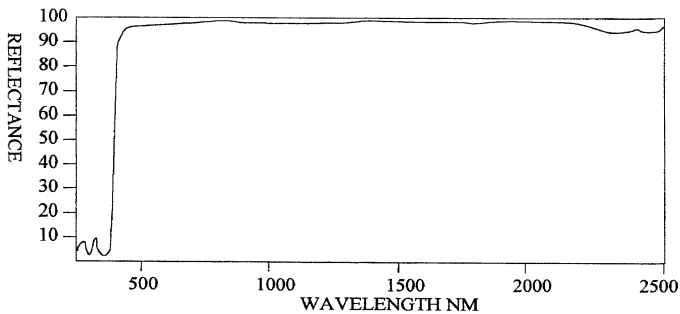
Claims

1. In a silver mirror, comprising a polymeric substrate, a thin specular-reflective silver layer overlying the substrate and bonded thereto, and a thin protective layer of film-forming polymer overlying the exposed surface of the silver layer, the protective layer firmly adherently bonded thereto, the improvement, comprising an ultraviolet absorbing polymer film adhered to the exposed surface of the protective layer.
2. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer is acrylic.
3. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer is selected from the group consisting of polycarbonate, polyester, polyethylene naphthalate or fluoropolymer.
4. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of an adhesive.
5. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of a solvent weld.
6. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of a thermal weld.
7. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of an ultrasonic weld.
8. A method for making a silver mirror, comprising the steps of:
 - (a) providing a polymeric substrate;
 - (b) bonding a specular-reflective silver layer to the substrate;
 - (c) bonding a thin protective layer of a film-forming polymer to the silver layer; and
 - (d) adhering an ultraviolet absorbing polymer film to the protective layer.
9. The method of claim 8, wherein the ultraviolet absorbing polymer is acrylic.
10. The method of claim 8, wherein the ultraviolet absorbing polymer is selected from the group consisting of polycarbonate, polyester, polyethylene naphthalate or fluoropolymer.
11. The method of claim 8, wherein the step of adhering comprises gluing or welding.

*FIG. 1*



*FIG.3*

*FIG. 4*

Claims

1. In a silver mirror, comprising a polymeric substrate, a thin specular-reflective silver layer overlying the substrate and bonded thereto, and a thin protective layer of film-forming polymer overlying the exposed surface of the silver layer, the protective layer firmly adherently bonded thereto, the improvement, comprising an ultraviolet absorbing polymer film having a thickness in the range of 40-60 g/m² (2-8 mil) adhered to the exposed surface of the protective layer.
2. The silver mirror of claim 1, wherein the ultraviolet absorbing film is an acrylic polymer.
3. The silver mirror of claim 1, wherein the ultraviolet absorbing film is a polymer selected from the group consisting of polycarbonate, polyester, polyethylene, polyethylene naphthalate or fluoropolymer.
4. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of an adhesive.
5. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of a solvent weld.
6. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of a thermal weld.
7. The silver mirror of claim 1, wherein the ultraviolet absorbing polymer film is adhered to the exposed surface of the protective layer by means of an ultrasonic weld.
8. A method for making a silver mirror, comprising the steps of:
- (a) providing a polymeric substrate;
 - (b) bonding a specular-reflective silver layer to the substrate;
 - (c) bonding a thin protective layer of a film-forming polymer to the silver layer; and
 - (d) adhering an ultraviolet absorbing polymer film having a thickness in the range of 40-60 g/m² (2-8 mil) to the protective layer.
9. The method of claim 8, wherein the ultraviolet absorbing polymer is acrylic.
10. The method of claim 8, wherein the ultraviolet absorbing polymer is selected from the group consisting of polycarbonate, polyester, polyethylene, polyethylene naphthalate or fluoropolymer.
11. The method of claim 8, wherein the step of adhering comprises gluing or welding.

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION (37 CFR 1.63)	Attorney Docket Number NREL 97-33
	First Named Inventor Gary J. Jorgensen
	Complete if Known
	Application Number /
	Filing Date
<input checked="" type="checkbox"/> Declaration Submitted with Initial Filing OR <input type="checkbox"/> Declaration Submitted after Initial Filing (surcharge (37 CFR 1.16 (e)) required)	Group Art Unit
	Examiner Name

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and solo inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A DURABLE CORROSION AND ULTRAVIOLET-RESISTANT SILVER MIRROR

the specification of which
☐ is attached hereto
OR
☒ was filed on (MM/DD/YYYY) (05.08.1999) as United States Application Number or PCT International

Application Number PCT/US99/17743 and was amended on (MM/DD/YYYY) (13.12.1999) (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached?
			YES	NO
			<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>
			<input type="checkbox"/>	<input type="checkbox"/>

☐ Additional foreign application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto:

I hereby claim the benefit under 35 U.S.C. 119(a) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
60/095,884	(10.08.1998)	<input type="checkbox"/> Additional provisional application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

[Page 1 of 2]

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DECLARATION—Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c) of any PCT international application designating the United States of America listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing of this application.

U.S. Parent Application or PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number (if applicable)
PCT/US99/17743	(05.08.1999)	

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet PTO/SB/02B attached hereto.

As a named inventor, I hereby appoint the following registered practitioner(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

<input type="checkbox"/> Customer Number	<input type="checkbox"/> Registered practitioner(s) name/registration number listed below	Place Customer Number Bar Code Label here	
OR			
Name	Registration Number	Name	Registration Number
KENNETH L. RICHARDSON PAUL J. WHITE	27,378 30,436		

☐ Additional registered practitioner(s) named on supplemental Registered Practitioner Information sheet PTO/SB/02C attached hereto.

Direct all correspondence to: ☒ Customer Number or Bar Code Label 23712 OR ☒ Correspondence address below

Name	PAUL J. WHITE		
Address	NATIONAL RENEWABLE ENERGY LABORATORY		
Address	1617 COLE BLVD., MS 27/224		
City	GOLDEN	State	CO
ZIP	80401-3393		
Country	USA	Telephone	303/384-7576
Fax	303/384-7499		

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both, under 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

Given Name (first and middle (if any))		Family Name or Surname	
GARY J.		JORGENSEN	
Inventor's Signature	Date		1/25/01
Residence: City	PINE	State	CO
Country	USA		Citizenship
Post Office Address			
Post Office Address	13662 DOUGLAS RANCH DRIVE		
City	PINE	State	CO
ZIP	80470		Country
USA			

☒ Additional inventors are being named on the 1 supplemental Additional Inventor(s) sheet(s) PTO/SB/02A attached hereto

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DECLARATION	ADDITIONAL INVENTOR(S) Supplemental Sheet Page <u>1</u> of <u>1</u>
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Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
<u>RANDY</u>				<u>GEE</u>			
Inventor's Signature	<u>Randy Gee</u>					Date	<u>2/8/01</u>
Residence: City	<u>ARVADA</u>	State	<u>CO</u>	Country	<u>USA</u>	Citizenship	<u>US</u>
Post Office Address							
Post Office Address <u>13991 WEST 54TH AVENUE</u>							
City	<u>ARVADA</u>	State	<u>CO</u>	ZIP	<u>80002</u>	Country	
Name of Additional Joint Inventor, if any:		<input checked="" type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
<u>DAVID E.</u>				<u>KING</u>			
Inventor's Signature						Date	
Residence: City	<u>LAKEWOOD</u>	State	<u>CO</u>	Country	<u>USA</u>	Citizenship	<u>US</u>
Post Office Address							
Post Office Address <u>13427 WEST EXPOSITION DRIVE</u>							
City	<u>LAKEWOOD</u>	State	<u>CO</u>	ZIP	<u>80228</u>	Country	
Name of Additional Joint Inventor, if any:		<input type="checkbox"/> A petition has been filed for this unsigned inventor					
Given Name (first and middle [if any])				Family Name or Surname			
Inventor's Signature						Date	
Residence: City		State		Country		Citizenship	
Post Office Address							
Post Office Address							
City		State		ZIP		Country	

Burden Hour Statement: This form is estimated to take 0.4 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, Patent and Trademark Office, Washington DC 023. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.